GEMFORM 7 User's Guide

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Executive Summary

This users guide describes the first stage development of a software package to support forest planning and monitoring called Gemform 7. Gemform comprises an Access application linked to an Access database called Gemdata. The initial version is designed to process data from management or strategic inventories, and pre-harvest stock surveys. It is intended that facilities to be completed later in the year will support stock mapping, skid trail planning, post-harvest silvicultural surveys and permanent sample plots.

Gemform groups data into projects. A project may be a concession or timber lease application, or any other operation requiring a forest management plan. Projects can have different sampling designs and species grouping systems.

Management inventory data is then organised by transects, plots, and on plots, by tree data, NTFP data, animal observations, and stump records. Data input forms are provided for these which are compatible with currently recommended field forms and procedures, and similar in use to software that has been used in the past.

Management inventory outputs include a monitoring module to assess progress and required sampling intensity, a flexible stand table module for many different stand table layouts, and a growth model for forecasting sustainable yield and Annual Allowable Cut. This model builds on work done by the author for GFC in 2000 and 2001 and incorporated into earlier, Excel-based versions of Gemform.

Pre-harvest survey data is also catered for. This is organised by blocks, and then by trees. The method can accept two types of survey, based either on two lines per strip with tree position estimated from these edge lines, or one central line per strip, with positions offset from this. The latter is noted as less accurate both because of the wider strips normally employed, and the lack of a definite edge to the survey strip. Survey data also includes entry of terrain features of relevance to skid trail design, such as streams, embankments, rock outcrops, steep slopes etc.

Pre-harvest survey analysis is currently limited to stock table outputs, again flexible in format, giving volume and tree numbers by size classes or above total size limits. Further work will build on this to produce ArcView compatible shape files of stock maps and skid trail plans.

The existing version Gemform 7.0 described in this guide is now operational. It will be progressively upgraded during the balance of the year with new facilities, and will also be converted to use SQL Server rather than Access as the back end database, for better data security and speed as the database becomes larger.

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Introduction

GEMFORM 7 is a *Microsoft Access* computer application designed to bring together several different pieces of software used by the Guyana Forestry Commission (GFC) into one convenient and user friendly package. The functions performed by version 7 include the following:

- Data entry and editing for pre-harvest inventory
- Progress monitoring and estimation of sampling requirements for inventories
- Stand tables (volumes and stocking for species by diameter class) for inventory
- Estimation of sustainable yield and annual allowable cut (AAC) for inventories
- Data entry and editing for stock surveys
- Stock tables from pre-harvest surveys

GEMFORM 7 incorporates volume equations and growth models based on past work and in use by the GFC through other systems. The name GEMFORM itself derives from *Guyana Empirical Modelling for Forest Management*. Previous publications by the present author describe earlier versions of GEMFORM and the technical and data basis for the growth models and volume equations used. These documents are available on the Internet (see References, Alder 2000, 2001).

An earlier version of GEMFORM (version 2), incorporating stand table and yield projection facilities, was developed in 2001 and has been used for a number of projects by the GFC. However, this was an Excel program that did not work properly for multi-user access on the GFC network. The present program incorporates the essential features in terms of flexible stand tables and modelling, whilst re-writing the system in Microsoft Access to permit network, multi-user operation, and adding additional features for data entry and management and for the pre-harvest surveys.

Gemform 7.00 is the first version of this new package, which is undergoing continuing development. The section on **Further Developments** highlights facilities planned for the near future.

Installation

File location

GEMFORM 7 follows the typical model of a Microsoft Access application. It comprises a front-end application (GEMFORM7.MDB) and a back-end database (GEMDATA.MDB). Other databases, provided they have the same format as GEMDATA.MDB, can be linked instead, but for this documentation, we will refer only to GEMDATA.MDB.

These files, together with a copy of this guide (GEMGUIDE.PDF) are available for download from the Internet as a ZIP package at the author's website: http://www.bio-met.co.uk/guyana/gemform7.zip. File size is approximately 2 MB. This file is password restricted.

A live version also exists on the GFC network. Currently this is located in the directory *G:\Gemform*, but could be moved (or the G: drive renamed) at the discretion of the GFC Network Administrator. Access permissions would depend on username.

It is important to note that the central database file GEMDATA.MDB should always reside on the shared network drive, and *never be copied to a local drive for working purposes with real data*. Otherwise, different, incompatible versions of the database will be created, leading to all sorts of severe problems in data management.

On the other hand, the application, GEMFORM7.MDB, can be used directly from the network drive, or copied to a local drive. The latter will be found to be more efficient if the system is busy.

When GEMFORM7 is being run from the network drive, two users with the same username cannot use the program at the same time. *They must be logged in under different Windows usernames*.

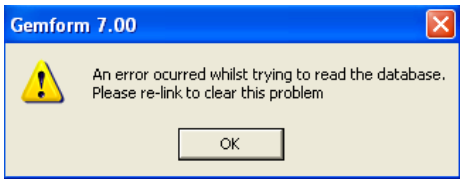
We may also note that in order to run GEMFORM7, *Microsoft Access 2000* or a higher edition must be installed on the local computer. If this is not the case, the program will not run. At GFC, *MS Access 2002* forms part of the normal installation on network workstations.

Starting Gemform

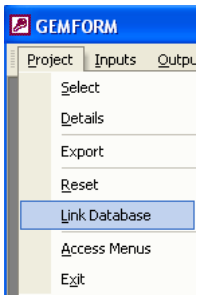
Gemform is started simply by clicking on the filename from Windows Explorer. The following screen will appear, indicating that the program has started correctly.

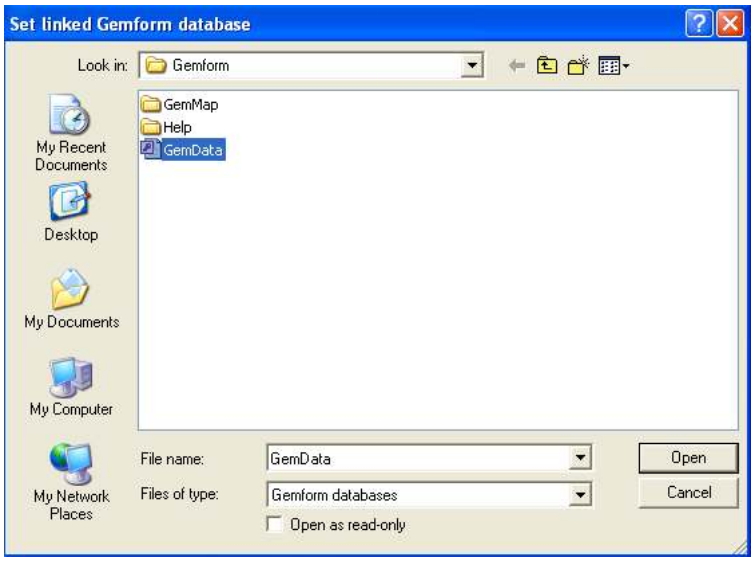
Linking the database

When Gemform is first installed, or if it is copied from another location, it will not be able to find the linked database. In this case the following error message will appear:



In this case select Link Database from the Project menu, as shown. A standard Windows file explorer box will open, which can be navigated to find the GEMDATA file. Double click on it to complete the linking process.

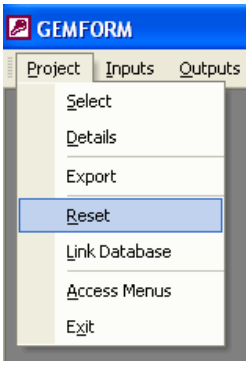




Re-linking *only needs to be done if the database is moved or re-named*. It does not need to be done unless the error message appears.

Program control

Control functions on the Project menu



There are several program control functions grouped under the Project menu, as shown at the right. These include Reset, Link Database, Access Menus, and Exit.

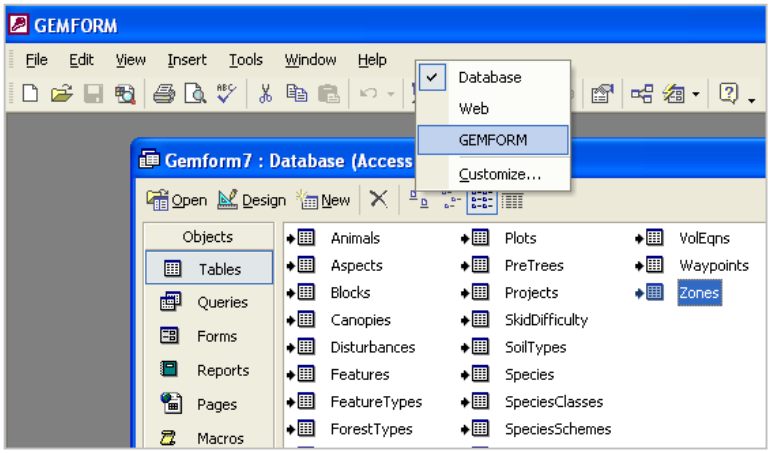
The Link Database function has been described above. It can be used at any time to change the linked database on which Gemform is working.

Reset function

The Reset function essentially restarts Gemform. It can be used after the program has halted for any reason. This will usually happen after an error message. It can also be used after moving to the Access menus to restore the menu bar and usual appearance.

Access menus

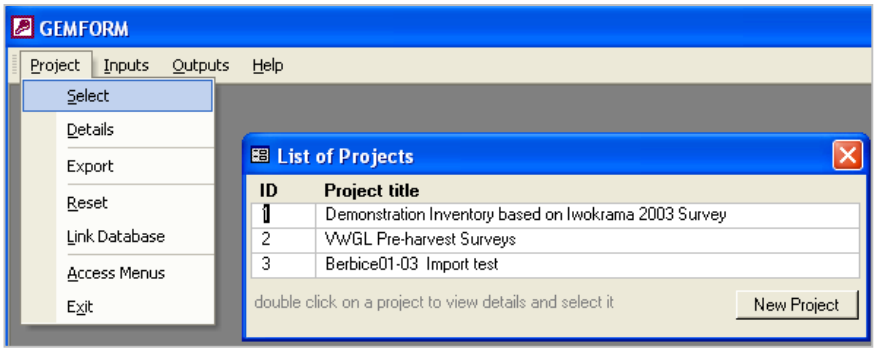
This option will hide the Gemform menu and restore the normal appearance of Access. This may be useful for viewing or editing any of the tables directly. When the Access menus are present, then right-clicking on the top menu bar will show a popup menu as shown. Click on the Gemform menu, and it will reappear below the main Access menu. You can then click Reset on the Gemform menu to restore Gemform's normal appearance.



Exit

The exit function closes the program. It has the same effect as closing the Access window.

Projects



What is a project?

In Gemform, a project is a grouping of all inventory, stock survey and other data relating to one company or concession.

Selecting a project

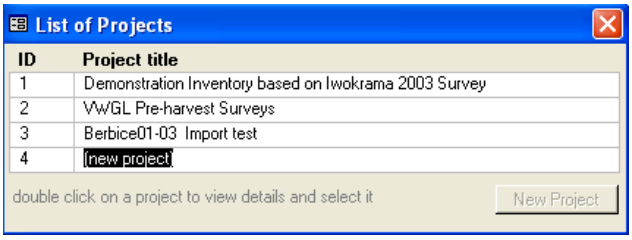
The Select menu will bring up a list of projects in the database, as shown. Double click on the required project and it will become the current project. Its title will appear on the Gemform splash screen. All functions except the program control functions noted above require that a project is selected before they will operate.

The project will remain selected until either it is changed, or the program halts with an error message. In the latter case, you will need to re-select the project.

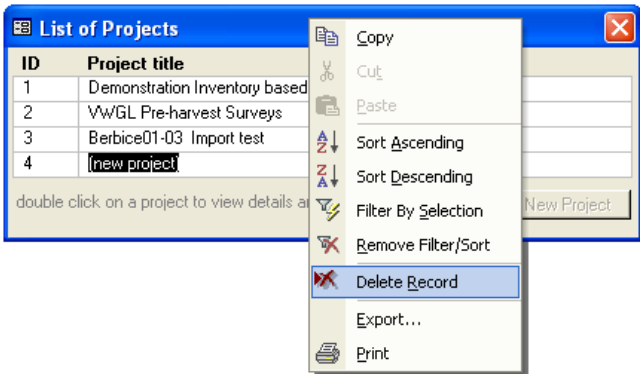
Using any menu for which a project is required when one has not been set will bring up the message *Please select a project first*.

Creating a new project

Clicking on the new project button will create an entry with the title *(new project)*. Double click on this to select. Note that the project title and other details cannot be edited on the List of Projects.


List of Projects
ID
Project title
1 Demonstration Inventory based on Iwokrama 2003 Survey
2 VWGL Pre-harvest Surveys
3 Berbice01-03 Import test
4 (new project)
double click on a project to view details and select it
New Project

Deleting a project

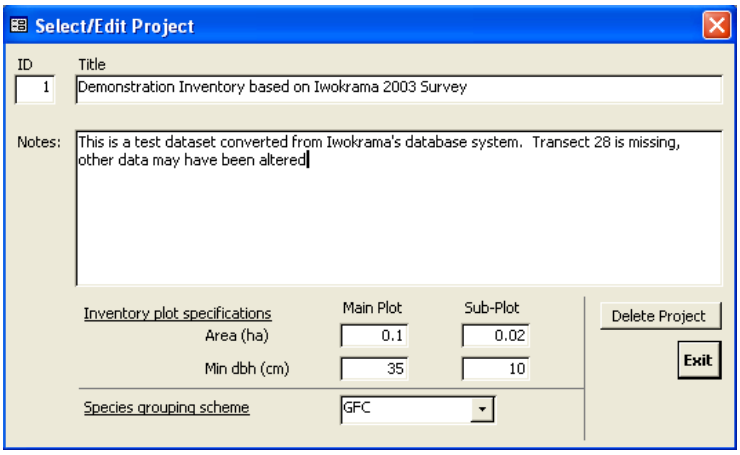


An empty project, which does not contain any inventory or stock survey data, can be deleted from this list. Right click over the list and a popup menu will appear with a Delete record option. Click on that to delete the selected record.

Trying to delete a project that contains data will have no effect. A system message will come up rejecting the attempted deletion.

If you do need to remove a project that contains data, then use the Export function described below. This allows a project and all its data to be copied to another database, and then removed from the current one.

Project details



Once a new project has been set, its details must be completed. These include the title. *This will appear on printouts such as stand tables, yield forecasts, etc. and should be appropriate for this purpose.* The project details box also allows notes to be entered. *It is recommended that essential file references for the concession, are included here, together with the name and contact details of the applicant or owner, and a brief description of the project.* Any amount of text can be written. This data will not appear on any outputs, but is very useful after one or two years in reminding you of the essentials of the project.

The inventory plot specifications must be given and are critical to giving correct figures on outputs. A mistake in plot size or threshold diameters will affect all calculations and give wrong results. The figures shown in the example are normal for GFC management inventories.

A species grouping scheme must also be selected, otherwise a number of outputs will be unavailable.

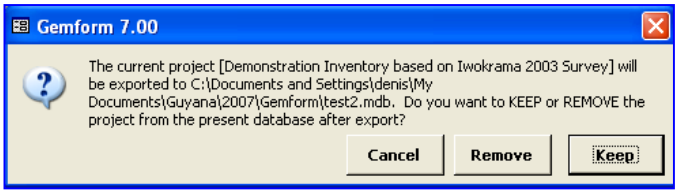
The delete project button is another way of deleting a project that contains no inventory or stock survey data. It will not function if the project has data.

Exporting projects

The Export menu allows a copy of the project data, together with all necessary supporting files, to be made as an Access database. This can be useful if you wish to set up an installation of GEMFORM for a company, by providing them with an empty database except for their own data, or perhaps a small demonstration dataset. Additionally, after export, the entire project

including any data can be deleted from the master database. This can be useful for archival purposes for old or abandoned projects.

When the export menu is selected, a file explorer window will come up. Find the target directory for the file, and type in the desired name for the export file. You may also select an existing file, which will be overwritten – the data is not appended to an existing file, and any data in it will be lost.


Gemform 7.00
The current project [Demonstration Inventory based on Iwokrama 2003 Survey] will be exported to C:\Documents and Settings\denis\My Documents\Guyana\2007\Gemform\test2.mdb. Do you want to KEEP or REMOVE the project from the present database after export?
Cancel
Remove
Keep

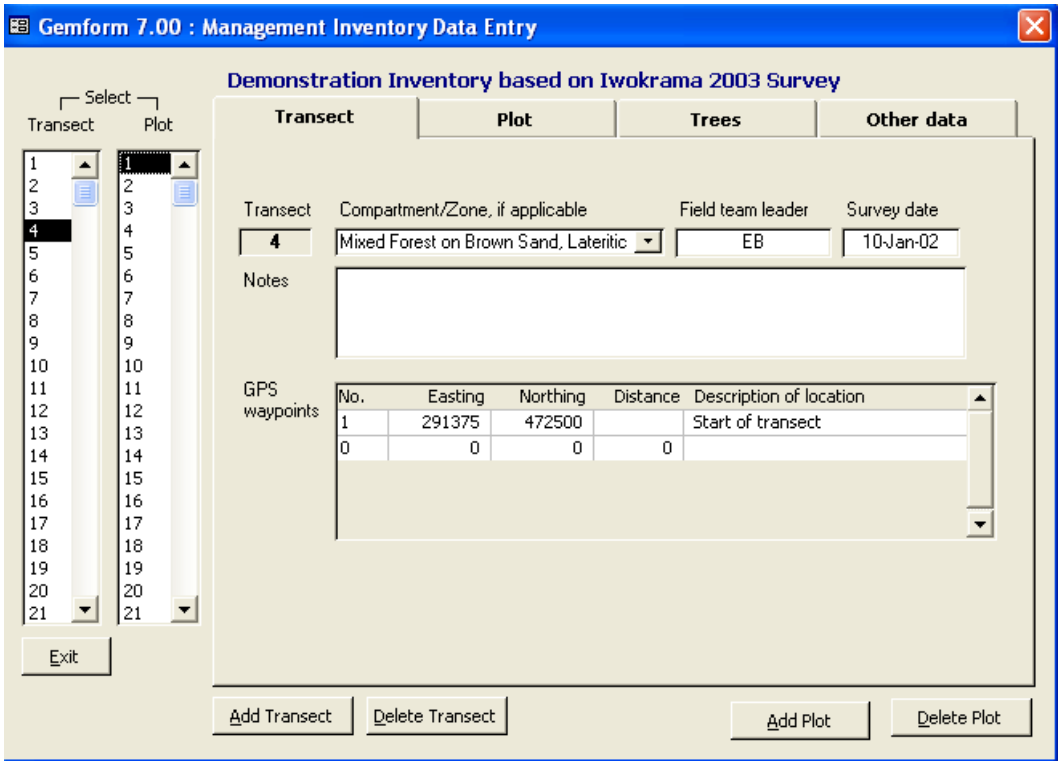
A dialog will then come up as per the example shown. Select Keep to make a copy of the project, but keep the original in the master database. Select Remove to delete the project from the master database once it has been exported. Cancel will abort the function without any action taking place.

The operation will then proceed. A dialog box with *File exported successfully* will come up on completion. On a network database, the process could take several minutes and should not be interrupted by, for example, opening other Gemform menus, but allowed to finish.

Inputs

Management or strategic inventory

The Inventory menu under Inputs will bring up the following screen form:



It is necessary to select first a Transect and then a Plot from the lists at the left. *For a completely new project*, click Add Transect, select it and fill in the details. Then click Add Plot to add the first plot. Select it, and at this point the Plot, Trees and Other data tabs will be enabled.

Transects tab

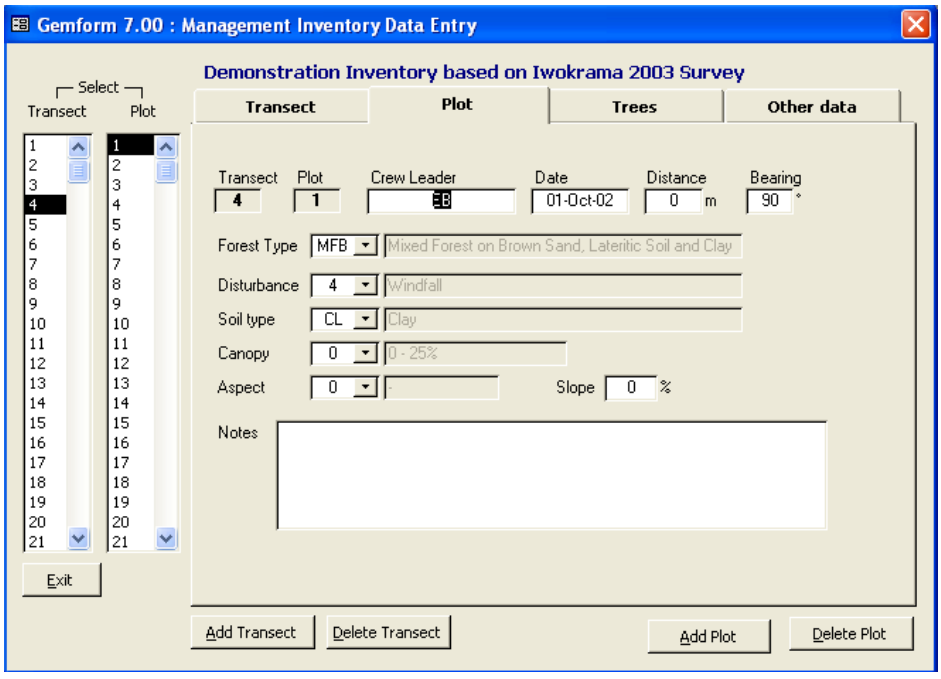
The Compartment/Zone options shown in the drop down list will be taken from the compartment list for the project, as described below under the **Compartments** heading.

The name or initials of the Team Leader and the date the transect was established should be entered. Date can be typed in either the *dd/mm/yy* or *mm/dd/yy* formats, *but will always be shown with the month in words to eliminate any ambiguity* between these two systems. The preferred system on any given workstation will depend on how its localisation has been configured and is outside the control of this software. Dates can also be entered in the format show eg. *21-aug-07* or *27/8/07* or *8/27/07* would all give the correct result. However, *1/12/07* would be ambiguous and might translate as *1-Dec-07* or *12-Jan-07* depending on the computer settings.

Notes should include any information relevant at the transect level.

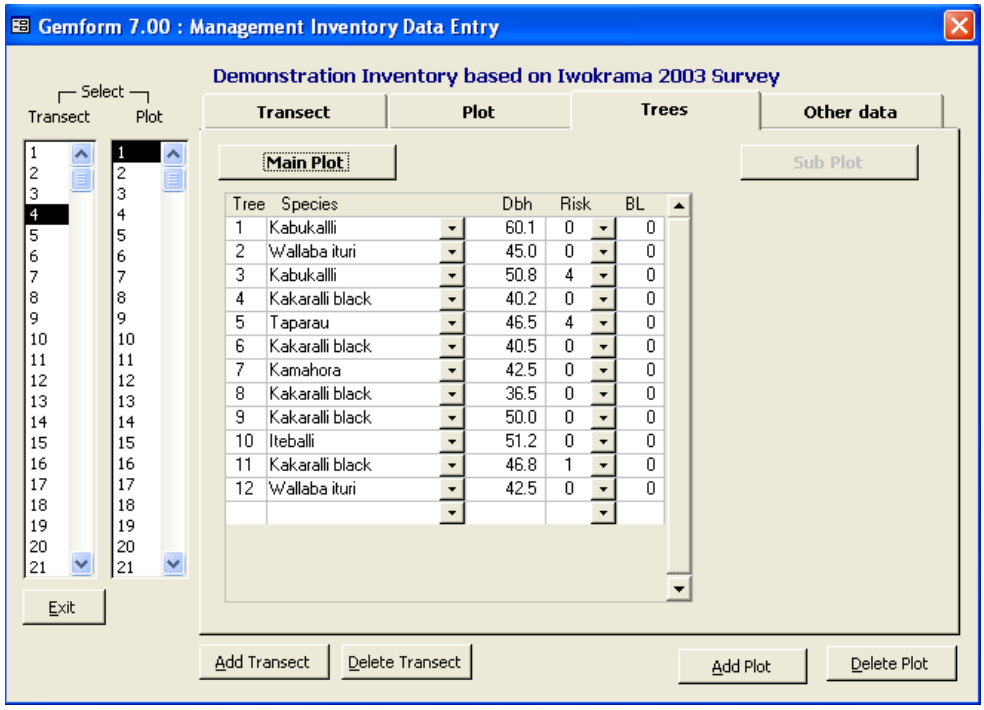
GPS Waypoints should be recorded in UTM coordinates. The UTM zone (20 or 21) should be put into the notes for the moment – this will be properly provided for in a later revision, as on the Pre-Harvest form. The Distance is distance from the start of the transect. Waypoints need to be recorded under relatively open canopy conditions, and cannot always be made at the start of the line. This system allows for flexibility in this respect. To confirm the bearing and straightness of the transect, ideally waypoints should be recorded nears the start and end, and at a few places (3-4) along its length. The description may be a physical locality if available on map (eg. *main road crossing*), or simply '*near plot 42*', or '*exact centre plot 50*'.

Plot tab



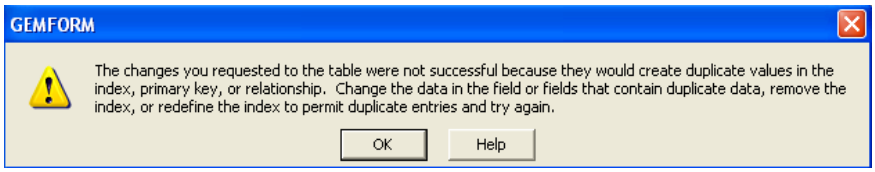
Under the Plots tab are recorded the various details of the plot. The measurement Crew Leader, the Date enumerated, distance from the start of the transect, and bearing of the transect line This latter seems redundant for straight transects, but has been provided in the past, so is included here. Forest type, disturbance, soil type, canopy closure and aspect are all selected from dropdown menus giving standard options. Note that none of these entries should be left blank. The Notes field can be used to record an peculiarities at the plot. All these data should be recorded according to GFC published procedures and using standard inventory forms.

Trees tab



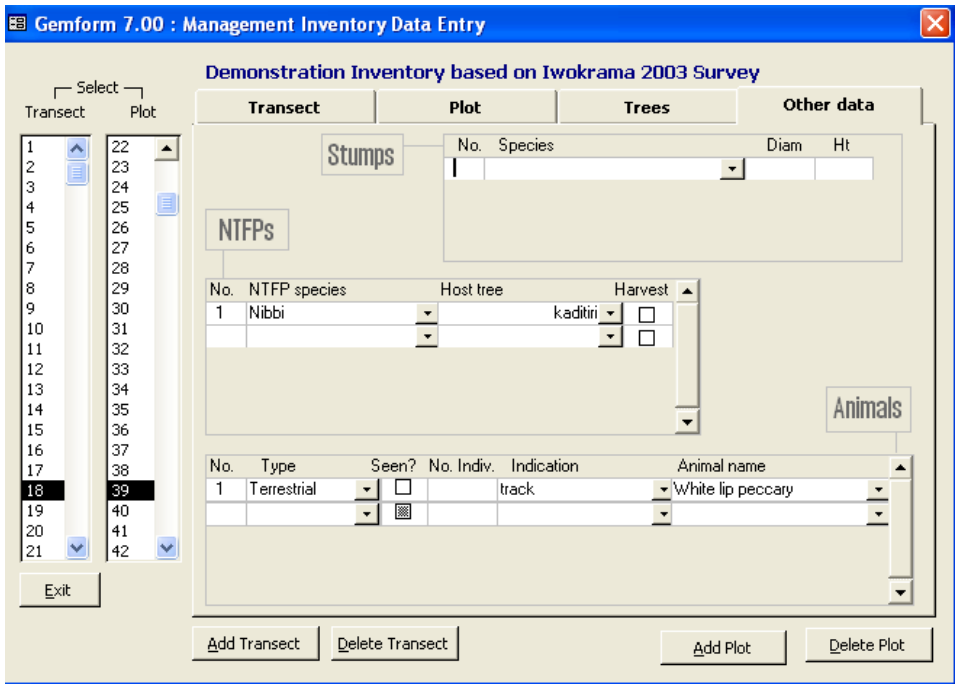
Tree data are entered for the main plot and sub-plot separately. Clicking the sub-plot button will bring up the tree list for the sub-plot. The data is entered as recorded on the data entry form. It is important not to leave Tree, Species, Dbh or Risk blank as errors may result in later processing. BL can be left empty as it is not used by the system, and has been included only for historical reasons.

New trees are entered by simply starting on a blank line. Note that duplicate tree numbers will be rejected by the system with the message shown below. If on the form, there are for example, two tree 12's for whatever reason, renumber them as 120 and 121 on entry. It is a good idea to add a note about this under the Plot tab if it occurs (eg *two tree 12's renumbered 120, 121*).


GEMFORM
The changes you requested to the table were not successful because they would create duplicate values in the index, primary key, or relationship. Change the data in the field or fields that contain duplicate data, remove the index, or redefine the index to permit duplicate entries and try again.
OK
Help

Other data tab

The Other data tab provides for data on Stumps, NTFPs, and Animals, as shown below.



The data are entered as recorded on the form. For NTFP species, Host Tree, Animal indication and name, flexible drop downs are provided that can be used either to select from a previous entry, or overtyped with a new name. As with the Trees tab , the No. field must always be unique, otherwise an error message will result.

Pre-harvest stock survey data

Blocks tab

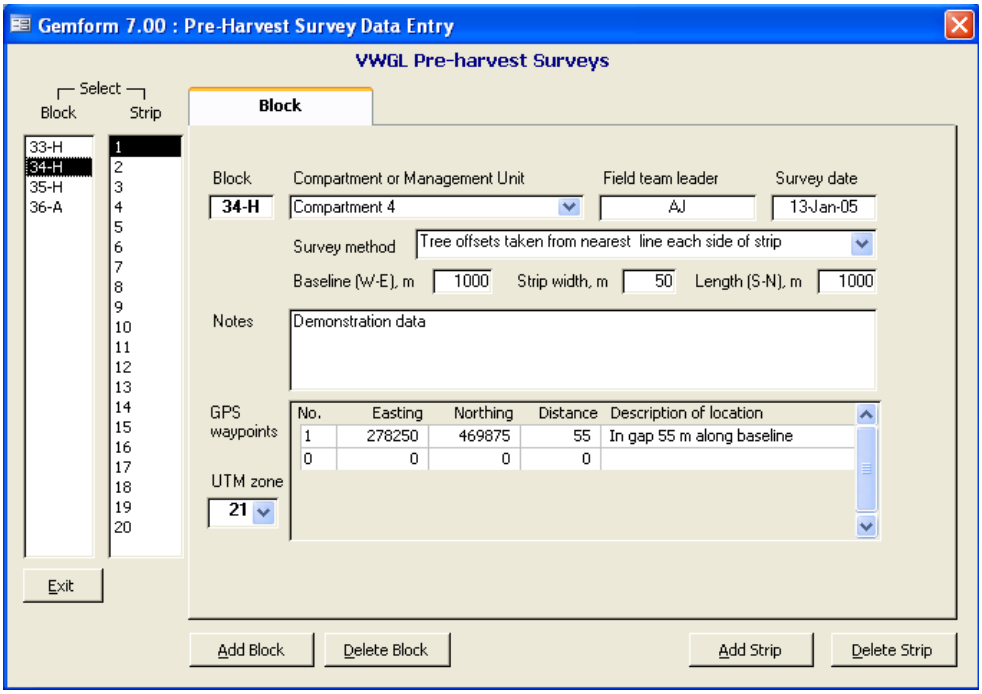
When Pre-harvest is selected from the Input menu, the screen form shown below will appear. This functions in a similar way to the Inventory input form. For a new project, the Block and Strip lists will initially be empty. It is necessary first to add a Block, and then to add a Strip before entering any data. The block names can be edited – initially a new block will be called (new). Block names should typically have the form 1-A up to 99-ZZ , ie. One or two numbers, a hyphen, and one or two letters, but the system does not require this format. Strips are always numbered sequentially and must be numeric.

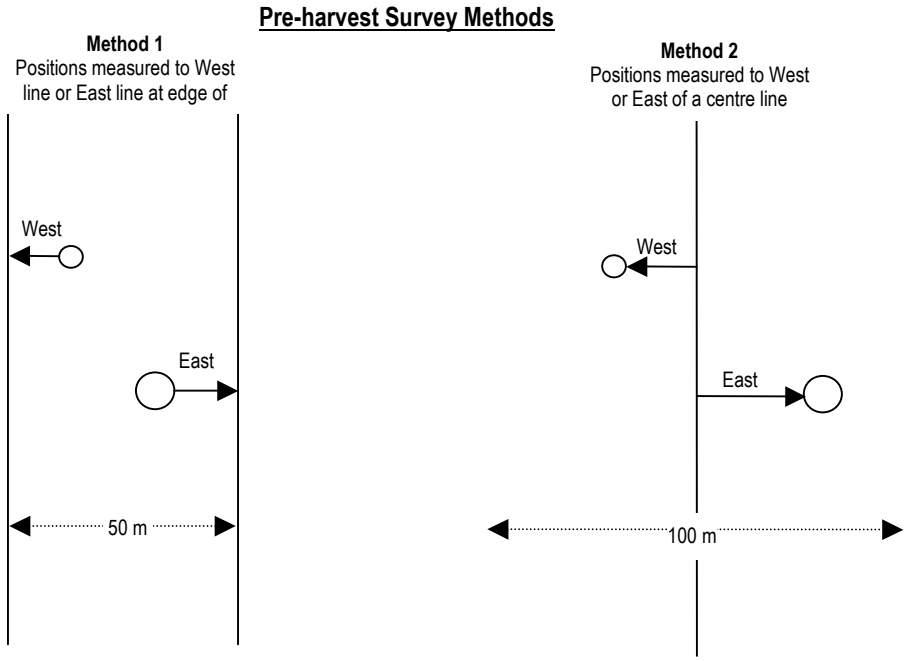
The Compartment or Management Unit will be selected from the drop down list. The list of compartments for this project can be set via the **Compartments** menu .

The Survey Method drop down gives two options:

1. *Tree offsets taken from nearest line each side of strip*
2. *Tree offsets taken from central line down strip*

These two methods are illustrated in the diagram below (**pre-harvest survey methods**). Method 1 uses lines 50 m apart, with tree spotters moving between the lines and giving offsets from each edge. The strip is between the lines.





Method 2 uses lines 100 m apart. Tree spotters move either side of the central line and estimate distances either to the West or East of the line. Method 2 is clearly less accurate: Estimation distances are twice as far, and the edges of the strip, which are the midway region between lines, are not well defined. Trees near the edge may be counted twice or missed altogether. However, the method is initially cheaper, with half the amount of line cutting and survey required.

The Block tab also records records Baseline length, strip width, and Length N-S. The baseline length is the East-West size of the block. Strip width is the distance between strip lines, as noted above. Although typically 50 or 100 m, the software allows other possibilities. The Length N-S, is North-South dimension of the block.

The Notes field allows any other observations at the block level. Note that the Terrain tab allows for a variety of site observations, so these do not need to be included in the notes.

As with transects GPS waypoints should be recorded at the very least near the beginning and end of the baseline. Ideally this would be exactly at the beginning and end, but canopy density may not permit this, so the distance along the baseline to the waypoint is recorded. Intermediate points allow the straightness of the line to be checked, and altogether they provide a check on orientation. The baseline should be well-located and oriented before any other work is done, to avoid costly re-survey. Preferably the data being entered in the system should be simply validating this fact, and not used to discover costly mistakes at a later date.

The UTM zone should also be recorded, either 21, for much of Guyana, or 20 for the North West[2].

Strip tab

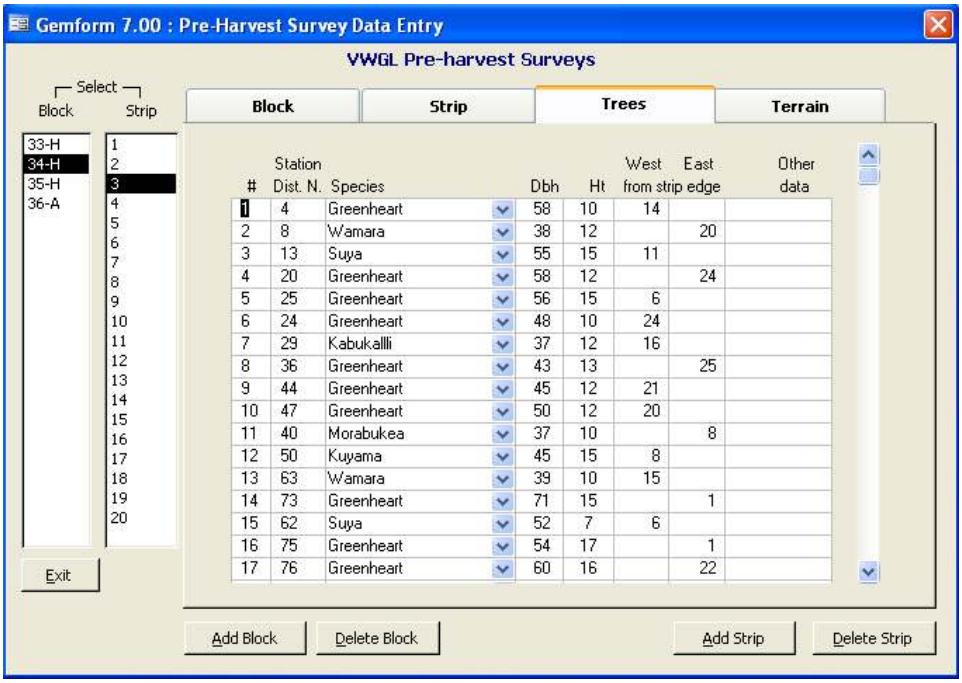
The strip tab is as shown below. Crew leader and date should be entered, and distance either to the line at the western edge of the strip, or to the centre line, depending on which survey method is used. The text on the form changes according to the method selected. The compass bearing should correspond to true North, with the appropriate correction for declination. The direction walked will be either from the baseline (S-N) or from the top of the previous strip (N-S). It is also possible for the block to be surveyed with the baseline along the North edge, in which case the compass bearing (~195°) and direction N-S and S-N entries would be given as they occur in practice. Notes would relate to any other matters of relevance.

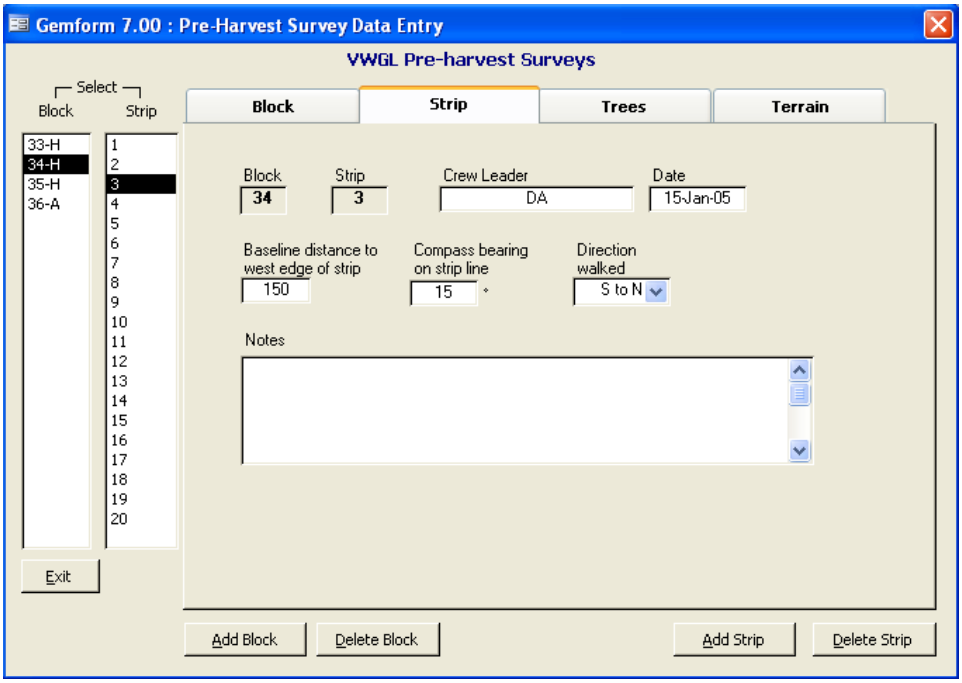
Trees tab

The tree number must be unique within the strip – duplicate numbers, if they occur, must be changed. The system will give an error message if an attempt is made to save data with the same tree number as one already entered, or with a blank tree number. Distance north, or station as it is often called, is then recorded. If the strip has been measured from the north, these distances should start at 1000 and go downwards. Species can be selected from the drop down list, which also reacts to any letters typed in. Dbh and bole height must be entered. Then the offsets are recorded either from the Western line and Eastern line (method 1) or to the

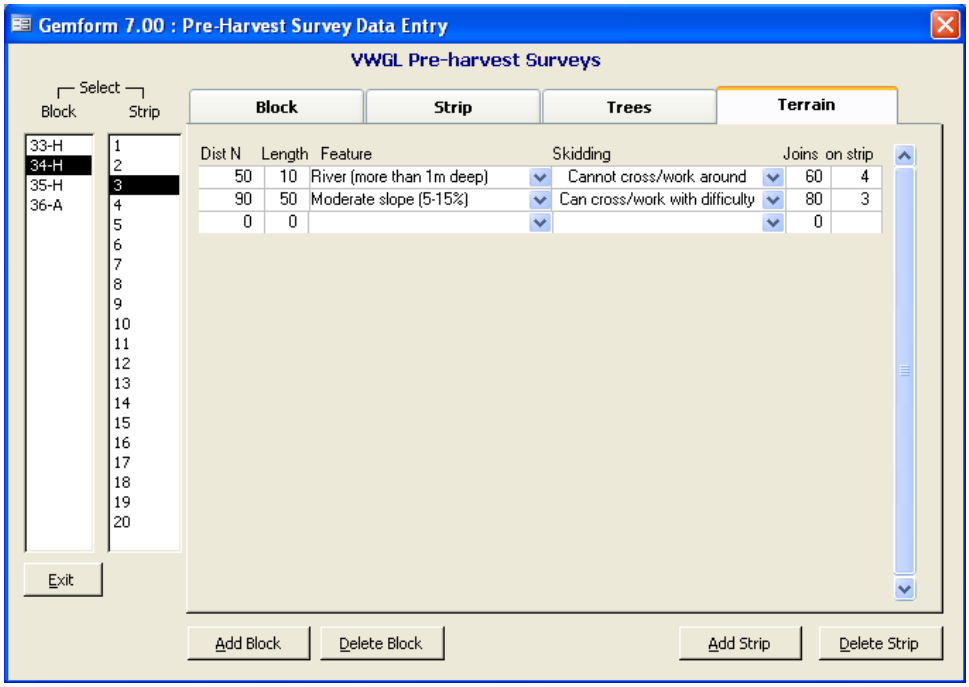
[2] The Transect tab (p.7) lacks this data, but this will be remedied in a later update.

West and East of the central line (method 2). Other data required by some companies, such as tag numbers can be recorded and will be transferred by Gemform to the stock map output, but is not used for any calculation and can be left blank if not collected.



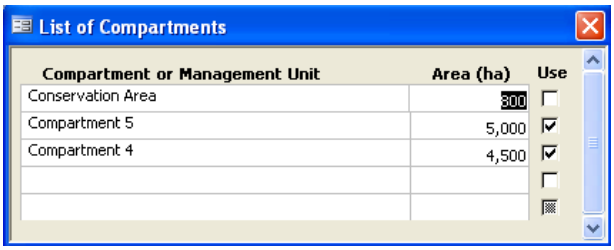


Terrain tab



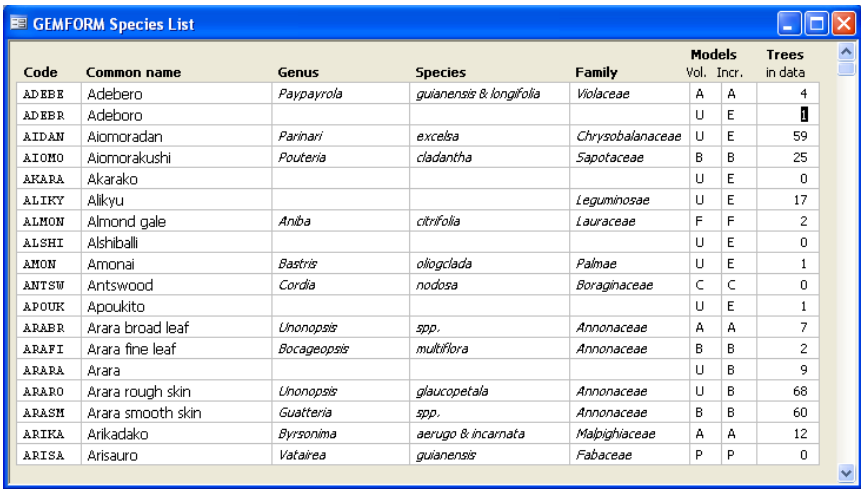
The terrain tab allows survey information relevant to the planning of skid trails to be entered. Features encountered along strips are recorded on a survey sketch as usual. This is then translated into entries on this form. The distance along the strip is recorded as Dist N, and the width of the feature along the direction of the strip is recorded as Length. The feature itself can be selected from a drop down, whose entries are given in the data table Features, which may be edited and added to if required. The effect of the feature on skid trail planning is selected from the Skidding dropdown. If it joins up with the same feature on another strip, the distance and strip number can be entered. This is especially helpful for linear features such as streams or roads., but may be regarded as optional if too time consuming.

Compartments



Compartments or other management units, such as zoning for types of use can be defined by the Compartments menu, which produces a list of compartments as shown. New entries can be added, and existing ones deleted. The compartments are used as units of stratification for the inventory reports. In the yield model, only compartments with the Use box ticked are included. The forest area of the compartment must be included for yield modelling.

Species List



Code	Common name	Genus	Species	Family	Models Vol.	Models Incr.	Trees in data
ADEBE	Adebero	*Paypayrola*	*guianensis & longifolia*	*Violaceae*	A	A	4
ADEBR	Adeboro				U	E	1
AIDAN	Aiomoradan	*Parinari*	*excelsa*	*Chrysobalanaceae*	U	E	59
AIOMO	Aiomorakushi	*Pouteria*	*cladantha*	*Sapotaceae*	B	B	25
AKARA	Akarako				U	E	0
ALIKY	Alikyu			*Leguminosae*	U	E	17
ALMON	Almond gale	*Aniba*	*citrifolia*	*Lauraceae*	F	F	2
ALSHI	Alshiballi				U	E	0
AMON	Amonai	*Bastris*	*oliogclada*	*Palmae*	U	E	1
ANTSW	Antswood	*Cordia*	*nodosa*	*Boraginaceae*	C	C	0
APOUK	Apoukito				U	E	1
ARABR	Arara broad leaf	*Unonopsis*	*spp.*	*Annonaceae*	A	A	7
ARAFI	Arara fine leaf	*Bocageopsis*	*multiflora*	*Annonaceae*	B	B	2
ARARA	Arara				U	B	9
ARARO	Arara rough skin	*Unonopsis*	*glaucopetala*	*Annonaceae*	U	B	68
ARASM	Arara smooth skin	*Guatteria*	*spp.*	*Annonaceae*	B	B	60
ARIKA	Arikadako	*Byrsonima*	*aerugo & incarnata*	*Malpighiaceae*	A	A	12
ARISA	Arisauro	*Vatairea*	*guianensis*	*Fabaceae*	P	P	0

The Species List menu brings up the table shown at the right. Users can add, edit or delete species from the list. A few points should be noted:

Code should always be 5 characters (preferably letters based on the name, similar to codes in use) and *must be unique*. The system will not allow a duplicate code to be entered.

Common name is the name used on all drop down lists for data entry, and therefore should be a standardised name.

Genus, Species and Family are for reference, and may be edited as required.

The Models entries Vol (volume) and Incr (increment) should not be changed. New species can be assigned the default volume model of U and increment model E in the absence of other information. These model codes, and detailed descriptions of their meaning, will be found in Alder (2000).

Trees in data shows the number of records in either the inventory or pre-harvest data that refer to this species. Only species with no records can be deleted from the list. The system will reject attempts to delete other records.

The list can be sorted on any column, or exported to Word or Excel, via the right mouse button popup menu.

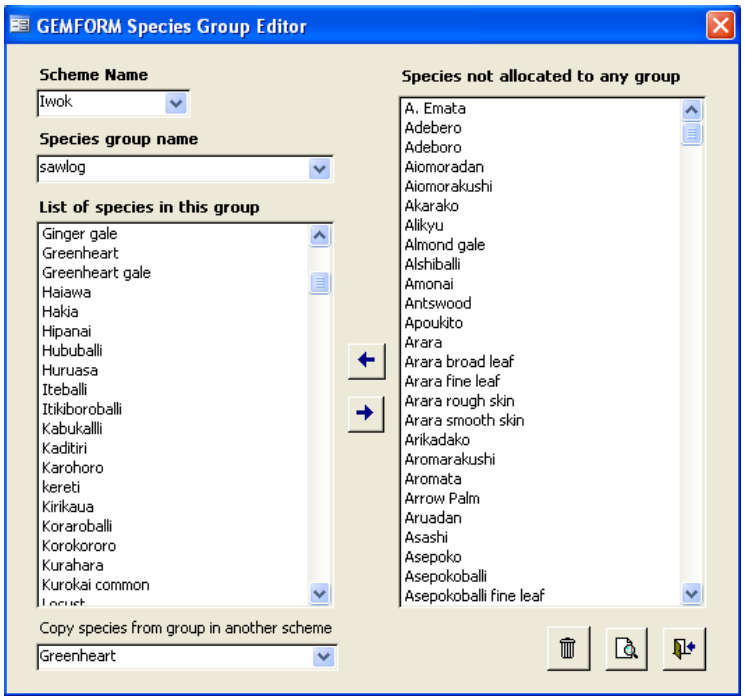
Species Groups

The Species Group menu allows species grouping schemes to be created, edited and if necessary, deleted.

A Scheme is a short code name for a set of species groups. Ideally there would be only one national species group classification (which we might call the *GFC scheme*). In practice, different organizations and companies will regard species as having different relevance to their operations. Iwokrama, for example, is trying to diversify forest use as much as possible, and has therefore a very broad and extensive set of groups. Many of the species in these might in practice be reckoned to be of little real commercial value. A large operational timber company would be focussed on a few high valued timbers for which it has current contracts.

Once a grouping scheme has been created, it is associated with a project via the Project Details menu. The grouping scheme for a project can be modified at any time.

If no scheme is assigned to a project, some outputs will not work properly. The inventory monitoring report (Outputs Monitoring) needs a scheme in order to estimate sampling error for classified species, as distinct from sampling error for all species. The stand tables reports can group species or they can provide ungrouped results. For grouped tables, a species grouping scheme needs to be defined.



A scheme is created by simply typing in a new name in the Scheme box (see screen form above). The system will ask *Do you want to create a new scheme?* If the answer is *no*, nothing is done. If *yes*, then a new empty scheme is started. New groups are added similarly by typing a new name in the Species group name. This will give the option of renaming an existing group, if there is one, or starting a new group.

Species are assigned to groups by selecting them in the right hand list, and clicking the left arrow button to move them into the left hand list. Several species can be selected at once using the conventional Windows selection keys: *Shift+left mouse button* selects everything from the last selection. *Ctrl+left mouse button* selects or de-selects individual entries. The right arrow button similarly allows species to be removed from a group.

Species can be copied from a group in another scheme. Selecting a group from the Copy species drop down at the bottom of the form will copy all species in that group into the present group.

Species cannot occur twice in more than one group. This is taken care of automatically, and one can be relaxed about moving species around between groups.

It is possible to have a group consisting of a single species. This might be useful for common, premium species such as Greenheart.

Many species will remain outside any group, and will be unclassified. In the various outputs, such species are lumped together as 'other species'. It is important for a scheme to be consistent and relevant with the objectives of management for a particular projects. Group names should also be suitably capitalised and formatted for appearance on reports. The name of the scheme does not appear on any printed output, and should be short.

The icons at the bottom of a form provide for the following actions:

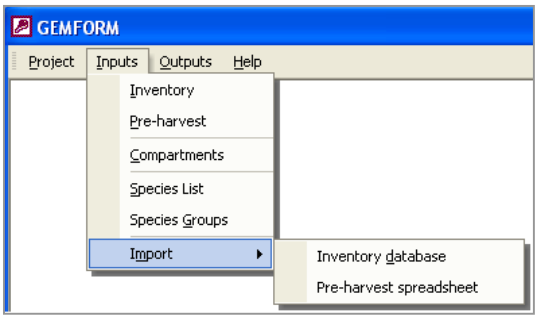
Any empty schemes or groups will be removed from the drop down lists and deleted. Note that when the form is closed, empty schemes and groups are always deleted.

Brings up a printable report (also exportable to Word or Excel) showing the groups and the species in them for a given scheme.

Closes the form. The action is the same as the close button at the top right of the window. All changes are saved, except as noted, that empty groups or schemes (with no species assigned) will disappear.

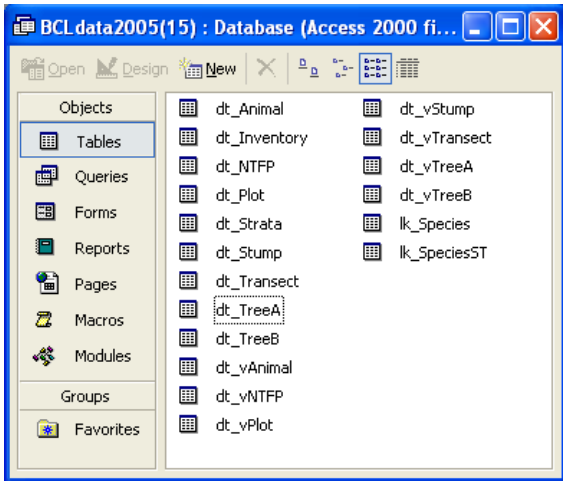
Import

The Import menu allows existing datasets to be imported into Gemform. Two kinds of data can be imported, either management inventory data, or pre-harvest stock surveys.

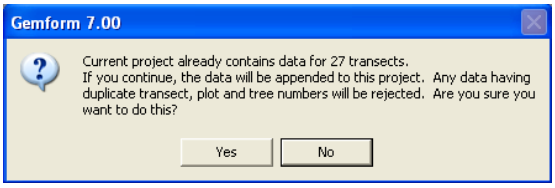


Inventory database

Management inventory data can be imported via the Inventory database menu. This must be in the format of the *Iwokrama inventory database*. These are Access files which, when opened in Access, will show a set of tables with the appearance shown below.



When the Inventory database menu is clicked, Gemform will check if the current project is empty. If not it will give a warning message, similar to that shown below.


Gemform 7.00
Current project already contains data for 27 transects.
If you continue, the data will be appended to this project. Any data having duplicate transect, plot and tree numbers will be rejected. Are you sure you want to do this?
Yes
No

It is better not to try and import data into an existing project unless you have renumbered transects beforehand to ensure there are no clashes. Otherwise the import will be unsuccessful, as the system will reject any duplicate transect numbers.

It is recommended that you start with an empty project (or at least, having no management inventory data). With an empty project, or by clicking *yes* to the warning message above, a file explorer box will then open. Use this to locate the required database to import, and click Open.

The data conversion and import will then proceed, and a notification will appear when the import is completed. The main causes of failure in this process will be duplicate transect or plot numbers, blank fields for transect or plot IDs or species codes. The process will also fail if the file opened for import is not in the correct Iwokrama database format. So far however with several files tested, the procedure works without problems.

After import, remember to fill in the Project Details, otherwise it will not be possible to do any analysis on the imported data.

Outputs

Monitoring

The Monitoring report will appear as shown below when the menu is selected. It lists all transects in the inventory for the current project, with number of plots per transect, date measured, and team leader. It then shows actual tree numbers per plot and subplot, and calculated total per ha. Basal area is then shown for all trees, for classified species, and for classified species on the main plot. The Coefficient of Variation (CV%) is shown for each of these basal area figures.

At the bottom it shows target numbers of plots required to achieve sampling errors of 5, 10 and 15% for each of these three classes of basal area.

This report allows the progress and required sampling precision of an inventory to be monitored. Basal area has the same statistical properties as volume, so the sampling error for basal area will be the same as that for volume.

Classified species are those which have been assigned to any species group under the grouping scheme set for this project.

GEMFORM Monitoring Report

Demonstration Inventory based on Iwokrama 2003 Survey

Transect	Date	Team Leader	No. of Plots	Trees per plot Main	Trees per plot Sub	Trees per ha	Basal area, m2 per ha: All trees	CV%	Class. spp.	CV%	Cl.spp. dbh>35	CV%
1	24-Sep-02	IJ	33	5	6	343	18.7	56%	0.7	158%	0.1	322%
2	27-Sep-02	WE	39	7	8	469	26.9	30%	1.5	103%	0.6	193%
3	29-Sep-02	WE	32	7	8	449	24.9	31%	2.0	106%	0.9	137%
4	10-Jan-02	EB	33	8	9	555	30.5	33%	2.5	148%	1.8	206%
5	01-Oct-02	WE	27	8	6	399	25.8	39%	6.0	187%	4.3	234%
6	10-Feb-02	WE	33	6	8	475	24.8	24%	1.8	146%	1.3	185%
7	03-Oct-02	EB	34	7	9	529	23.3	31%	1.6	137%	0.6	142%
24	19-Jul-05	EJ	15	5	6	369	18.3	33%	1.4	102%	0.5	132%
25	21-Jul-05	GA	25	5	7	419	27.3	48%	1.3	118%	0.6	212%
26	18-Jul-05	BX	7	4	5	286	17.0	21%	1.2	141%	0.9	203%
27	24-Sep-02	IS	41	6	7	420	24.3	44%	1.7	133%	0.5	184%
All transects			**869**	**5**	**7**	**411**	**21.7**	**40%**	**1.7**	**177%**	**0.8**	**289%**

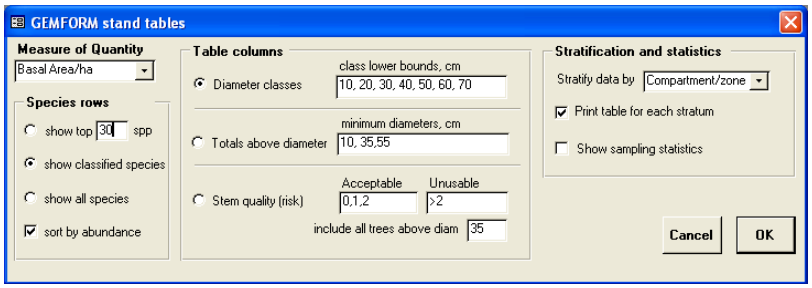
Plots required to achieve target sampling errors of:				
	5%	253	5012	13408
	10%	63	1253	3352
	15%	28	557	1490

There are two situations which will prevent this report from running: If no project has been selected, or if no species grouping scheme has been set for the project. Both of these will produce clear warning dialogs.

Sampling error is used here in the same sense as in the GFC management inventory procedures. It is the 95% confidence interval expressed as a percentage of the mean. A sampling error of 10% means that there is a 19/20 probability (0.95) that the true population mean is within ± 10% of the sample mean.

Stand Tables

The Stand Tables menu brings up an options screen which controls the layout of the stand table. When the required options have been set, the ok button will then bring up the report, in a style similar to that shown below.



GEMFORM Stand table

Demonstration Inventory based on Iwokrama 2003 Survey

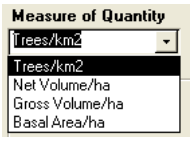
Trees/km2 by diameter classes (cm)

Species	10-20	20-30	30-40	40-50	50-60	60-70	70+	Total	SE%
Forest Total									867 plots
Major Commercial Species									
Baromalli	1,003	421	190	108	48	16	2	1,790	13.1%
Mora	531	190	67	74	95	76	170	1,202	43.9%
Wamara	669	225	121	61	27	14	12	1,128	20.8%
Crabwood	375	213	92	25	6	-	-	712	25.0%
Baromalli sand	185	104	44	20	10	3	1	367	65.9%
Kabukalli	98	46	33	28	33	32	44	315	39.2%
Shibadan	63	63	20	18	10	2	3	181	85.5%
Silverball	87	40	13	-	-	-	-	140	111.0%
Greenheart	40	23	2	18	9	16	13	122	850.8%
Purpleheart saka	12	23	40	8	6	6	3	98	228.2%
Purpleheart	-	12	14	3	3	5	3	40	670.1%
Locust	-	6	-	-	5	-	-	10	1170.5%
Baromalli swamp	-	6	-	-	-	-	-	6	-
Subtotal for species group	**3,062**	**1,373**	**637**	**364**	**253**	**171**	**251**	**6,111**	
Sampling error %	*10.2%*	*13.7%*	*16.4%*	*12.2%*	*15.2%*	*19.9%*	*19.1%*	*7.4%*	
Other spp									
All other species	15,923	4,752	1,467	608	262	186	157	23,354	3.6%
Subtotal for species group	**15,923**	**4,752**	**1,467**	**608**	**262**	**186**	**157**	**23,354**	
Sampling error %	*4.5%*	*6.9%*	*11.4%*	*10.4%*	*13.8%*	*16.4%*	*17.5%*	*3.6%*	
Total, all species	**18,985**	**6,125**	**2,104**	**972**	**514**	**356**	**408**	**29,465**	
Sampling error %	*4.0%*	*5.9%*	*9.3%*	*7.9%*	*10.0%*	*12.6%*	*13.2%*	*3.1%*	

The options that can be set for the stand table include the following:

Measure of quantity

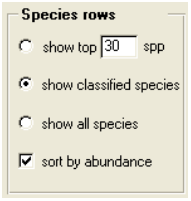
The stand table can summarise four quantities: *Tree numbers per km²*, *Basal area per ha*, *Gross volume in m3/ha* or *Net volume in m3/ha*. Net volume uses a net volume equation (see Alder, 2000) based on the CIDA-IFP defect and decay studies done in the 1970's. It also discounts volumes with higher risk classes, according to factors tabulated in the table *StemRisk* within the database. Gross volume uses the gross volume equations from Alder (2000), without any deduction for risk, defect or decay.



The selection of measure of quantity is made via the dropdown list on the form.

Species Rows

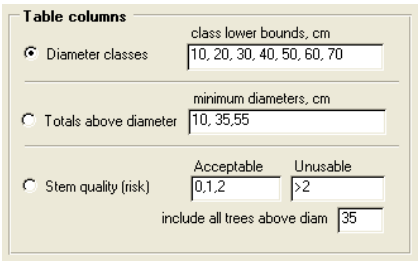
There are four options controlling how species rows are presented. They may be shown purely based on the most abundant species, selecting the top 20 or whatever number is required. Alternatively, species may be shown by species groups. In this mode, unclassified species (those not in any group) may be shown lumped as '*other species*', or, if the *show all species* option is selected, they will be individually listed.



Species will be shown in order of abundance if the *sort by abundance* box is ticked. Otherwise, they will be listed in alphabetical order of common name. The measure of abundance used is percentage of total basal area.

Table columns

Three types of columns may be selected four the table: Simple diameter classes, cumulative totals above a diameter, or stem risk (quality) classes. For each of these categories, the class limits and number of classes can be defined flexibly. However, no more than 8 classes are permitted.



For diameter classes, class lower bounds are specified. The example shown will give 10-20, 20-30, … 60-70 and 70+ cm. A tree exactly on the class bound will go into the higher class. For example, a tree of 20 cm would go into the 20-30 class, not 10-20.

For totals above diameters, the relevant diameter boundaries are listed.

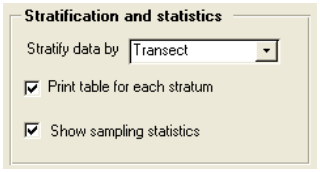
For stem risk, the classes listed in *Acceptable* are shown individually, whilst those in *Unusable* are grouped together into one class. The stem risk classification also has a smallest diameter parameter. Trees below *the include all trees above diam* value are excluded from the table.

Stratification and statistics

There are three ways the data may be stratified for sampling error calculation: By compartment, by vegetation type, or by transect. All methods are weighted by numbers of

plots per stratum. The vegetation type is recorded on the plot form, and must use categories which exist in the ForestTypes database table. This can be extended to include new or different type classifications if desired.

If stratification is by compartment, this must have been set for every transect during data entry, otherwise an error will occur when the table is generated.



Tables can be printed for every stratum, or only a whole forest summary printed. The former option can consume large amounts of paper, and is often not needed.

The checkbox *Show sampling statistics* will result in sampling error being printed for the column totals and for the subtotal rows.

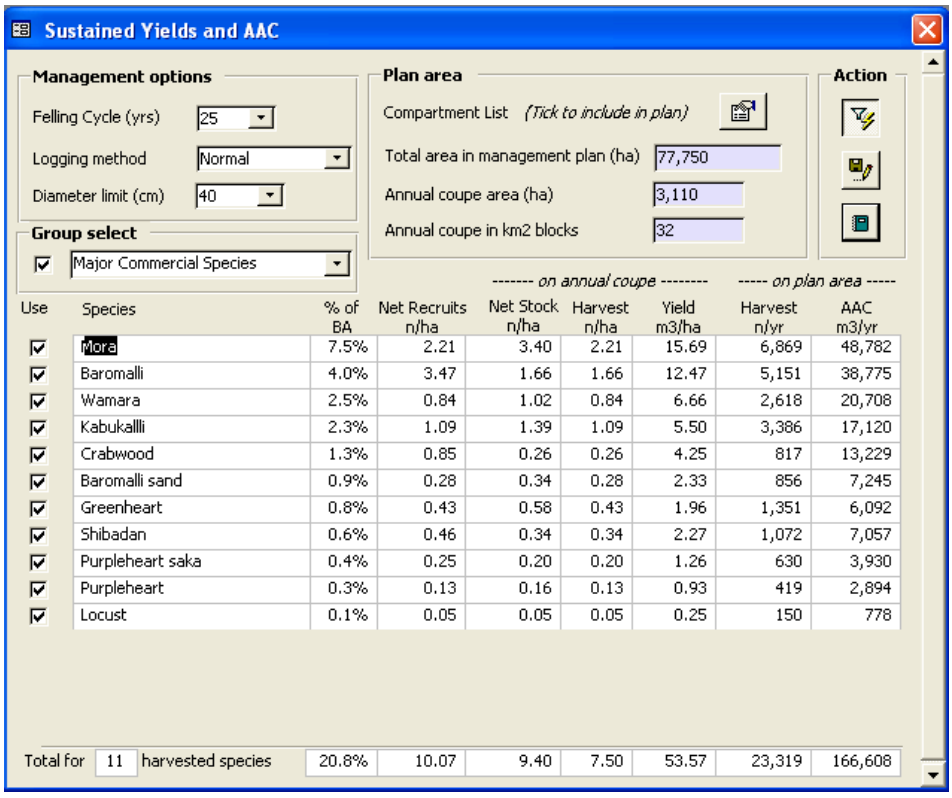
Saving of options

The various options set on the stand tables form, as with the stock tables and sustained yield report are always saved as part of the project, and will re-appear as set next time the form is opened.

Sustained yield

In many ways the sustained yield model is the heart of Gemform, and contributes to the package its name: Guyana Empirical Model for Forest Management. The details of the model are documented in Alder (2000).

The objective of this model is to estimate a level of harvesting that can be sustained for the foreseeable future. This is done by restricting harvesting to a level that will be fully replaced by recruit trees, after allowance for mortality and logging damage. The harvest level is given in practical terms that can be related to management and control.

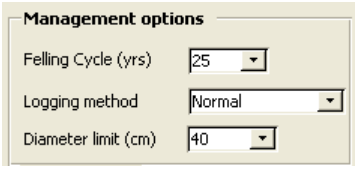

Sustained Yields and AAC
Management options
Felling Cycle (yrs) 25
Logging method Normal
Diameter limit (cm) 40
Group select
Major Commercial Species
Plan area
Compartment List (Tick to include in plan)
Total area in management plan (ha) 77,750
Annual coupe area (ha) 3,110
Annual coupe in km2 blocks 32
Action
-------- on annual coupe -------- ----- on plan area -----
Use Species % of BA Net Recruits n/ha Net Stock n/ha Harvest n/ha Yield m3/ha Harvest n/yr AAC m3/yr
Mora 7.5% 2.21 3.40 2.21 15.69 6,869 48,782
Baromalli 4.0% 3.47 1.66 1.66 12.47 5,151 38,775
Wamara 2.5% 0.84 1.02 0.84 6.66 2,618 20,708
Kabukallli 2.3% 1.09 1.39 1.09 5.50 3,386 17,120
Crabwood 1.3% 0.85 0.26 0.26 4.25 817 13,229
Baromalli sand 0.9% 0.28 0.34 0.28 2.33 856 7,245
Greenheart 0.8% 0.43 0.58 0.43 1.96 1,351 6,092
Shibadan 0.6% 0.46 0.34 0.34 2.27 1,072 7,057
Purpleheart saka 0.4% 0.25 0.20 0.20 1.26 630 3,930
Purpleheart 0.3% 0.13 0.16 0.13 0.93 419 2,894
Locust 0.1% 0.05 0.05 0.05 0.25 150 778
Total for 11 harvested species 20.8% 10.07 9.40 7.50 53.57 23,319 166,608

The Sustained Yield menu will produce the option screen shown at the right.

On this screen, the

following details may be noted:

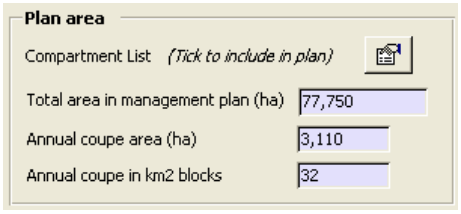
Management options



The felling cycle and minimum diameter limit may be varied as required within the limits imposed by the drop-down menus. The model results will update as the values are changed.

Two logging methods are listed: Normal and Reduced impact. In various publications the author has discussed the results of various logging trials as they may be represented as rules of thumb. Basically for conventional logging, for every m2/ha extracted, another m2/ha of the residual stand will be damaged and will die over the following 10-15 years. We classify this as a damage ratio of 1 (BA damaged/BA logged). For reduced impact logging, the equivalent damage factor is reduced, and may be taken as a rule of thumb as 0.6. The drop down boxes therefore apply a factor of 1.0 for normal logging, and 0.6 for reduced impact logging. For background information on this and other modelling aspects, see for example Alder *et al* (2002), Alder & Silva (2000), Alder (1999, 1998, 1995) and related publications on the author's website http://www.bio-met.co.uk, as well as publications specifically related to Gemform (Alder, 2000, 2002).

Plan area



The plan area shows the forest area covered by the model, as a total area and annual coupe, expressed both in ha and in km² blocks. The annual coupe is the total area divided by the felling cycle. These data cannot be edited but are picked up from the Compartment List. The button brings this list up as a popup – only the compartments checked as Use will be included in the plan area.

It follows from this that if compartments have not been defined for a project or given an area, then this model cannot be used. A simple approach is to have one 'compartment' for the whole project, whose area represents the estimated forested area.

Action buttons

There are three action buttons shown at the top right of the form. They are:

Filters the results table to show only those species being harvested. It also updates the model when clicked to reflect changes in species selection.

Writes the current option settings to disk. These will re-appear as default settings next time the form is opened for this project (each project has its own defaults). Options are always saved when the form is closed.

Summarises the model outputs and assumptions in printable report format. This may also be exported to Excel or Word.

Species selection

Species can be selected individually for inclusion in the model by checking the use box. Alternatively, a group can be selected or de-selected as a whole using the group select dropdown box. The display can be filtered to only show selected species using the button.

Model output columns

The various columns in the model output are:

% of BA	Percentage of total basal area represented by the species.
Net recruits n/ha	Calculated number of recruits growing above the diameter limit over the felling cycle, after allowing for deaths from natural mortality and logging damage.
Net stock n/ha	The current stock, in trees above the diameter limit.
Harvest n/ha	The number of trees that may be sustainably harvested. This is the lesser of the current stock, or the net recruitment.
Yield m3/ha	The estimated net volume that will be sustainably harvestable.
Harvest n/ha	The total number of trees harvested per annum on the concession, based on the annual coupe and the harvested trees per ha.
AAC m3/ha	The Annual Allowable Cut, or yield per ha multiplied by coupe area. It is a figure that can be monitored as the most the concession can sustainably produce per annum.

Totals row

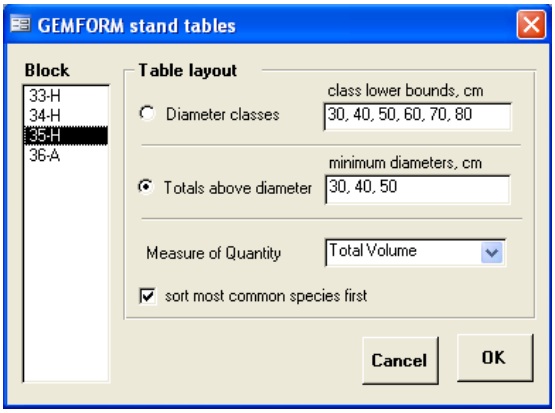
The totals row at the bottom of the form shows the sum of these various statistics for all the selected species.

Printable Report

The printable report produced by the button has exactly the same columns as the above, but is well formatted, and can be exported to Word or Excel. However, it is always filtered to only show selected species, irrespective of the filter status on the screen form.

Stock Tables

Stock tables are produced from pre-harvest inventories, and resemble the stand tables, but with simplified options. When the Stock tables menu is slected, the form at the right will appear. It is possible to show either conventional diameter classes, or totals above given diameter. The table can give total stem numbers, or total volume on the survey block. Species may be sorted by name, or with the most abundant first.



There is also a block selection list, which will show all the blocks in the project.

Volumes in the stock survey are calculated differently to the inventory, as they include estimated log height. An average form factor, based on volumes from the CIDA-IFP volume studies, is used, of 0.63. Volume is therefore estimated as:

$$v = f\ k.d^2.h$$

Where:

v is tree log volume
d is dbh in cm
h is log length in m
f is the form factor of 0.63
k is 0.00007854, or $\pi/40{,}000$

If a project is selected which does not have any pre-harvest data, then the block list will appear blank.

Further Developments

Gemform 7.0 is an interim version of what is intended to be an integrated package including also post-harvest (silvicultural) surveys and permanents sample plots. The pre-harvested facilities will also be enhanced to assist stock mapping and skid trail planning. The following schedule of developments is proposed over the next 6 months:

Stock mapping and skid trail planning	Using the ESRI MapObjects software library, a form will be added that can represent pre-harvest surveys as a tree map, and impose on it potential skid trail layouts. The stock map and skid trails will be output as shape files to enable high quality publication through GFCs GIS unit.
Conversion of the back-end database to SQL Server	The back-end database, GemData is currently in Access. This has limitations both in terms of data security (*see red-lined paragraph on page 2*) and speed as the database gets larger. As GFC is using Microsoft SQL Server, the backend database will be converted to this format for better performance and security. Access is mostly compatible with SQL Server.
PSP data entry and analysis	Modules will be added to enter PSP data and produces analyses of growth and mortality rates. The current GFC PSP datasets will be loaded as a part of this module.
Post-harvest survey data entry and analysis	Post-harvest data processing, currently provided by the Excel Silvicultural Survey macros will be converted to become part of Gemform.

Any feedback from users of the present system in terms of problems or suggestions for improvements or different layouts for reports will be very helpful during this devevlopment process. The author can be contacted by email on denis@bio-met.co.uk.

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Alder, D (1995) Growth modelling for mixed tropical forests. Oxford Forestry Institute Tropical Forestry Paper 30, 231 pp.[3]

[3] Printed copies of this manual are available by post. Please contact denis@bio-met.co.uk to request one.

Appendix A : Gemdata structure

This diagram shows the data tables, fields and relationships currently within Gemdata.